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Research Article

FACTORS AFFECTING THE SUSTAINABLE ADOPTION OF OILSEED CROPS IN PUNJAB: A CASE STUDY OF DISTRICT LAYYAH

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Abstract

There is a considerable gap between demand and supply of edible oil in Pakistan. The Government fills the gap by importing edible oils from other countries, costing billions of dollars. Efforts to boost oilseed crop yields at the federal and provincial levels have remained largely unsuccessful. This study compares the profitability of oilseed crops with its competing crops to find out factors that will aid in the sustainable adoption of oilseed crops. Primary Data were collected from 120 randomly selected farmers. Among 120 farmers, 60 were those growing oilseed crops, and rest were those growing crops other than oilseed crops. The determinants impacting the sustainable adoption of oilseed crops were identified using logistic regression. It was found that education, farming experience, subsidy, availability of quality seed and quality pesticides, availability of loans, and water availability issue were the factors that have a positive impact on oilseed crops adoption. Low-market-price, high-cost-of-fertilizer were the factors that decreased the adoption of oilseed crops.

Keywords: Adoption, Logistic Regression, Sunflower, Canola, Oilseed Crops.
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1. INTRODUCTION

In 2020, the worldwide market of cooking oil was valued at 186.55 billion US dollars. The market is predicted to increase from USD 204.74 billion in 2021 to USD 281.72 billion in 2028, expanding at a CAGR of 4.67 percent between 2021 and 2028. According to a report by the Organization for Economic Co-operation and Development (OECD) and the Food and Agriculture Organization (FAO), the availability of vegetable oil in the least developed countries is projected to increase by 1.3% per year until it reaches 9 kg per capita in 2030, up from 7.96 kg per capita in 2020. According to research by the Foreign Agricultural Service of the United States Department of Agriculture, Pakistan's total oilseed consumption is not predicted to increase much in 2022-23 due to a gradual recovery in edible oil demand (USDA, 2020). Edible oil seeds in Pakistan describe a policy failure (Zuberi, 2022). About 85% to 87% of overall consumption is fulfilled by imports, whereas only 13% to 15% is met by domestic output. The edible oil consumption per capita in Pakistan has climbed from 5.31 kg in 1973-74 to 20 kg in 2018 and is expected to reach 22 kg by 2028. Total consumption is anticipated to reach 6.5 million tons by 2028, whereas local production is less than 0.5 million tons, expanding the demand-supply mismatch.

The total cost of importing these products in the fiscal year 2021 has topped $4 billion, putting a strain on the country's trade and payments balances. It is expected that the import cost would rise due to the global uncertainties and issues facing the oilseeds business, such as sudden price fluctuations, market instability, and favourable import taxes.

It's important to note that federal and provincial initiatives to boost the output of oilseed crops have been ineffective so far. This agricultural sector has been mostly ignored for the last two decades because of unfavourable edible oil import rules. At the federal level, there are three primary institutions/organizations working together to promote and grow the oilseed crop: the National Agriculture Research Centre (NARC), the Agricultural and Biological Engineering Institute (ABEI), and the Pakistan Oilseed Development Board (PODB) Islamabad Oilseeds Program, on the other hand, focuses on the creation of new varieties and the dissemination of such types. ABEI is also tasked with developing novel oilseed crop production methods. Oilseed promotion efforts, such as introducing new varieties and production technology, are handled by the PODB. Traditional and non-traditional oilseed crops are divided into two categories. Traditional oilseeds include rapeseed/mustard, peanut, and sesame, whereas non-traditional ones include Sunflower and Canola. Many of the vital fatty acids and calories which humans need daily are found in oils, the most potent reserves of the plant kingdom (Ahmad et al., 2021).

A total of 213 Mha of the world's arable land is devoted to oilseeds, making them the fourth most significant food commodity after cereals, vegetables and melons, and fruits and nuts (OECD and FAO, 2020). There is an ever-increasing need for oil crops due to the high population density, the wide variety of food preferences people have, the growing global wealth, and the need for more sustainable bio-products (Zuberi, 2022).

Due to the Government's inability to increase local edible oil production, 70 per cent of the edible oil needed to meet domestic demand is imported. Since 1970, the annual import of edible oil has climbed by 12.5 per cent, which will continue to rise due to population growth. Canola and Sunflower, two non-traditional oilseed crops, have the potential to close the supply-demand imbalance in Pakistan (Amjad, 2014). The import of edible oils has drained many foreign reserves. Imports in 1980 cost Rs. 2.3 billion; by 2009, they had grown to Rs. 84 billion (GoP, 2009). A drop in domestic output, an increase in worldwide pricing, and a surge in Pakistani demand are all factors that are expected to lead to the rise in Pakistan's edible oil import bill for the financial year 2021-22. "Rising worldwide market prices and the opening of Afghan trade would increase the edible oil import bill by 30% in the current financial year" (Mahmood, 2021). To fulfil rising demand, Pakistan's Marketing Year (October/September) 2021/22 edible oil imports are expected to reach a record 3.7 million metric tonnes (MMT) (USDA, 2021).

One of the most significant plants for bioenergy applications is Canola (Brassica napus L), which has more than 40% oil in its seed. Canola's 2019 worldwide output was 70 million tonnes, with 23 million tonnes of those coming from Europe alone (FAO, 2021). As a spring crop, Canola has grown more competitive and promising due to the global increase in canola prices (Prysiazhniuk et al., 2021). Currently, Ukrainian canola production is geared for export to the European Union and is sent out as soon as the harvest season ends (Shvidenko et al., 2017). Breeders and agronomists have a significant challenges in developing new varieties with more reliable yields and quality features. To do this, we must uncover and evaluate data from multi-environment studies that previously had been buried (Tsialtas et al., 2017).

Sunflower may become the preferred oilseed crop due to global environmental changes and its capacity to thrive in various agro-ecological situations, including mild drought. Even climate change models indicated an increase in the yield of sunflower in northern Europe, this may not be the case in the southern latitudes (Debaeke et al., 2017). Because of its adaptability to climate change, Sunflower is likely to have a long and prosperous future. As a result, breeding should get more attention to adapt better to climatic changes. The introduction of insect resistance, salt tolerance, and modifications in plant architecture should also be included in these features for improved adaptation (Dimitrijevic and Horn, 2018). Production increases for sunflower seeds that are slower than they were 15 years ago suggest that present resources and breeding practices may not be enough in the face of climate change. With its wide genetic basis and new technologies that enable the mining of features and genes from the vast and relatively unexplored gene pool of wild crop relatives, the sunflower crop, on the other hand, has a solid chance of surviving in a changing environment. When it comes to adapting to changing environments, sunflowers have been suggested as a possible model crop (Terzić et al., 2020).

2. Objectives

The objectives of the present study are;

- **a)** To find out the factors that affect the sustainable adoption of oilseed crops in District Layyah.
- **b)** To suggest policy recommendations for the adoption of oilseed crops

3. Methodology

3.1. Sampling Framework

To estimate and analyze the profitability of canola and sunflower crops relative to other competing crops, we will get a list of beneficiaries of the Government's oilseed promotion plan from the district's office of agricultural extension, Layyah. The district was selected based on the maximum area under the oilseed crops. The data was gathered and evaluated using a well-structured questionnaire. The extension department of the district has compiled a list of beneficiaries of the Government's subsidy plan. To determine the parameters influencing the sustainable adoption of oilseed crops (Canola and Sunflower) in the study district. A total of 120 farmers (60 farmers who were growing oilseed crops while 60 were those growing other than oilseed crops, especially wheat and sugarcane) from selected districts were surveyed. The selection of the farmers was made by using a random method. A well-designed questionnaire was used for the collection of data from the respondents. The data were analyzed using descriptive and logistic regression models to determine the variables influencing the adoption of oilseed crops.

4. Statistical Analysis

4.1. Logistic Regression Model

In statistics, the (binary) logistic model (or logit model) predicts the chance of one event (out of two options) occurring by combining one or more independent variables linearly with the log-odds (the logarithm of the odds) for the event ("predictors"). Logistic regression (or logit regression) estimates the parameters of a logistic model in regression analysis (the coefficients in the linear combination). Formally, in binary logistic regression, there is a single binary dependent variable, coded by an indicator variable, with two values labeled "0" and "1". In contrast, the independent variables may be binary (two classes coded by an indicator variable) or continuous (any real value) variable (Mehmood Hafiz Z.; Abbas Azhar, 2013).

The range of odds is between 0 and infinity, defined by probabilities. Odds are defined as the ratio between the probabilities of success and failure. The odds of success are odds(success) = p/(1-p) or p/q,

odds(failure) = q/p

To estimate the pragmatic model, the standard BLR approach was used. Exemplary of the general form of the laudable logit model are the following:

$$Li = ln\ (Pi/1 - Pi) = \beta\circ + \beta 1X1i + \beta 2X2i + \cdots + \beta kXki,$$

Where L is the log of the probabilities of farmers adopting oilseed crops, sometimes known as the logit, and Pi is the likelihood of a farmer adopting oilseed crops (conditional). X1i to Xki represent the stimulus, whereas 0 represents the model's intercept and 1 to k represent the coefficients of the independent variables.

Considering the BLR model, this research has two potential outcomes: the possibility of a household adopting oilseed crops or not. In this instance, the dependent variable is a dummy variable that takes the value 1 if a farmer has embraced oilseed crop and the value 0 if the farmer has not adopted oilseed crop. In the case of a dichotomous response variable (Y) and a vector of explanatory variables (X), the probability may be expressed as follows:

$Pi = Prob\ (Yi = 1) = 1/1 + e^{(-(\beta\circ+\beta 1X1+\cdots+\beta kXk)} = e^{(\beta\circ+\beta 1X1+\cdots+\beta kXk} / 1+ e^{(-(\beta\circ+\beta 1X1+\cdots+\beta kXk))}\ldots\ \ldots\ \ldots\ .\ .\ (1)$

Similarly; $Pi = Prob\ (Yi = 0) = 1 -prob\ (Yi = 1) = 1/1+ e^{(-(\beta\circ+\beta 1X1+\cdots+\beta kXk)}$ ....(2)

where Pi is the probability that a farmer will adopt Oilseed Crops and (1-Pi) is the probability that the farmer will not adopt Oilseed Crops. The Pi/(1-Pi) is simply the chances ratio in favor of joining Oilseed Crops. The odds of a specific event occurring are defined as the proportion of the likelihood of happening to the probability of not happening. Now, when we divide (1) by (2), we get:

$Prob\ (Yi = 1)/Prob\ (Yi = 0) = Pi\ /1 - Pi = e^{(\beta\circ+\beta 1X1+\cdots+\beta kXk)}$

We will now calculate the odds ratio log by taking the preceding equation's natural log.

$Li = ln\ (Pi/\ (1 - Pi) = \beta\circ + \beta 1X1i + \beta 2X2i + \cdots + \beta kXk,$

Where 1, 2,..,k represent the partial slope variables that illustrate the change in L for a unit change in the stimulus variables (Xk1, Xk2,..., Xki). In other words, it indicates how the log of the chances favoring producers' involvement in Oilseed Crops vary with the unit change in a particular predictor. This model's predictors were selected based on the relevant literature and the specific circumstances in the research region.(Mehmood and Azhar,2013; Sarfraz, 2013)

y= β_(0)+ β_(1) X_(1)+ + β_(2) X_(2)+ β_(3) X_(3)+ β_(4) X_(4)+ β_(5) X_(5)+ β_(6) X_(6)+ β_(7) X_(7)+ β_(8) X_(8)+ β_(9) X_(9)+ β_(10) X_(10)+ε

Where as

y = d, oilseed_cult = Probability of adoption of Oilseed Crop, 1 if adopted otherwise 0

X1 = education = Education (No of Years of Schooling)

X2 = farm_exp = Farming Experience (No of Years of Experience)

X3 = area_cultivated = Area Cultivation (No of Acres of Cultivation)

X4 = subsidy = Subsidy, 1 if received otherwise 0

X5 = water_issue = Water_issue, 1 if face otherwise 0

X6 = quality_seed = High Quality Seed, 1 if available otherwise 0

X7 = quality_pest = High Quality Pesticide, 1 if available otherwise 0

X8 = high_cost_f = High Cost of Fertilizer, 1 if face otherwise 0

X9 = low_m_price = Low Market Price, 1 if face otherwise 0

X10 = loan = Loan, 1 if loan is taken from anyone/ any bank/ institute

Where β1, β2,…,β10 are the partial slope variables representing the change in y for every unit change in the stimulus variables (X1, X2,..., X10). In other words, it describes the relationship between the unit change in a particular predictor and the likelihood of producers participating in Oilseed crop production.

5. Results:

The estimated results of the model are given in table 1. The variable education shows positive and significant relationship with dependent variable. It can be described that for every unit increase in education, the odds to adopt oilseed crops cultivation increases by 1.337 times higher or 33.7% more likely to be adopted oilseeds crops. The variable farming experience is a continuous variable and shows a positive and significant relationship with regressed. It explains that for every unit increase in farming experience, the odds to adopt oilseed crops cultivation increases by 1.141 times higher or 14.1% more likely to cultivate oilseed crop.

The variable subsidy also depicts positive and significant relationship with dependent variable and it could be described that the probability of those receiving subsidy were 3.919 time more likely to adopt the oilseed crops as compared to those who do not receive subsidy. The variable water_issue odd ratio indicates that the probability of adoption of oilseed crops is 8.84 times more likely to grow oilseeds crops for those who have no water issue. The probability of growing oilseed crops is 16.44 times higher for those who have the access of quality seeds as compared to those with no access to quality seeds.

Table 1: Results of Binary Logistic Regression

Number of observations			120		
LR $chi^2(10)$	116.72		Log likelihood	-24.214642	
Prob > chi^2	0.0000		Pseudo R2	0.7068	
d_oilseed_cult	Odds Ratio	Coef.	Std. Err.	Z	P>z
Education	1.337163	.2905502	.1793697	2.17	0.030
Farming_exp	1.14163	.1324574	.0463069	3.27	0.001
Area_cultivated	.928697	-.0739728	.0483123	-1.42	0.155
Subsidy	3.919567	1.365981	3.292743	1.63	0.104
Water_issu	8.84463	2.17981	8.566768	2.25	0.024
Quality_seed	16.44889	2.800258	19.03575	2.42	0.016
Quality_pest	21.18523	3.053304	22.58061	2.86	0.004
high_cost_f	.1838392	-1.693694	.1617343	-1.93	0.054
low_m_price	.2181939	-1.522371	.1957835	-1.70	0.090
Loan	16.34014	2.793625	17.05596	2.68	0.007
_cons	.0001146	-9.074089	.0003014	-3.45	0.001

The variable high cost of fertilizer has negative and significant relationship with dependent variable and illustrates that the probability of growing oilseed crops is 0.18 times less likely to grow the crops or 18.3 percent less likely to cultivate oilseed crops as compared to those who have more resources for the purchase of fertilizer. Low market price odd ratio indicates that the probability is 50% less likely to cultivate oilseed crops. The odd ratio of variable loan indicates that every unit increase in loan, the odds to adopt the oilseed crops is 16.34 times higher than those who do not receive loan.

5.1. Heteroscedasticity Test

Breusch–Pagan test is a chi-squared test used to determine the heteroscedasticity under the null hypothesis that there is a homoscedasticity in the data. If the test statistic has a p-value below a predetermined threshold (e.g., $p<0.05$), then the homoskedasticity null hypothesis is rejected and heteroskedasticity is accepted. Since the P value of chi2 is 0.12 which is greater than 0.05, So we do not reject the null hypothesis.

Table 2: Result of Breusch-Pagan / Cook-Weisberg test

chi2(1)	=	2.41	
Prob	>	chi2 =	0.1205

5.2. Multicollinearity Test

Multicollinearity test is used to find out the multicollinearity issue in the data and the results are given in table below.

Table 3: Results of Variance Inflation Factor

Variable	VIF	1/VIF
water_Issu	1.41	0.709404
quality_seed	1.33	0.754537
farming_exp	1.28	0.783484
high_cost_f	1.24	0.807650
Education	1.23	0.810864
Subsidy	1.22	0.822317
Loan	1.14	0.874812
Area_cultivated	1.11	0.904710
quality_pest	1.09	0.915672
low_m_price	1.03	0.966936
Mean VIF	1.21	

Variance Inflation Factor (VIF) is a measure of multicollinearity in the set of multiple regression variables for each independent variable. The greater the value of VIF, the greater the correlation between this variable and the other variables. If the VIF value is more than 10, it is often regarded as strongly associated with other independent variables.(Wu, 2020). Since the VIF values of each variable of our model ranges between 1-1.5, that shows there is no multicollinearity between variables of the Model.

5.3. Model Specification Test

Linktest is used to check either model has any specification error. If the p-value of hatsq is greater than 0.05 than it is failed to reject the assumption that the model is correctly specified. The following table shows that p-value of _hatsq is greater than 0.05 which means that the Model is correctly specified. (Willard, 2022).

Table 4: Results of linktest

d_oilseed_~t	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
_hat	.8333714	.1660071	5.02	0.000	.5046031	1.16214
_hatsq	.1849537	.1689196	1.09	0.276	-.1495827	.51949
_cons	.0074123	.0406549	0.18	0.856	-.0731026	.0879271

According to Brown *et al*., (2016) subsidy support increases the adoption of bioenergy crops. Střeleček *et al*., (2009) found that production-type-based subsidies may impact production diversity. Water is an important variable in crop production. Water limitation is becoming a severe issue in Pakistan. The results of our study supported by Zubair and Ghafoor, (2017), who concluded that yearly surplus wheat output might be substituted with oilseed and pulses, since wheat, cotton, and sugarcane need more water than oilseed crops. According to Nasir *et al*., (2021) oilseeds and pulses are possible agricultural diversification and resource conservation choices. Availability of quality seed is vital for adoption of oilseed crops. As per results, high quality seeds increases the adoption of the crops. According to Nasir *et al*., (2021), many factors effect on the adoption of sunflower which includes shortage of quality seed, high production costs (particularly seed costs), ineffective marketing, lack of adequate farm equipment for small farmers. Similarly, those who have access of quality pesticides are more likely to grow the crops. According to Kole, (2019), Sunflower production were hampered due to many factors including the non-availability of quality seeds.

Input costs including fertilizer influence the operational costs and profitability for farms that utilize improved production technology for crop production against those that do not (Schimmelpfennig, 2018). A price reduction might significantly lower the number of acres under contract for growing oilseed crops. In contrast, the identical adjustment implemented as a price increase might substantially increase enrollable acres (McCollum *et al*., 2021). Canola prices must be much higher than normal to encourage the expected increase

6. Discussion

The positive and significant result of education is supported by the results of Jensen *et al*., (2012), Singer *et al*., (2007), and Embaye *et al*., (2018) have also indicated that education increased farmers' willingness to accept new technology and to cultivate oilseed crops. Moreover, higher education benefits land allocation decisions for bioenergy crop production (Lynes *et al*.,2016; Jensen et al., 2012). Farming experience plays important role in adoption of new technology and new crops. It has also a positive and significant relationship with regressed. The results of this study are also endorsed by the results of Jensen et al., (2012) who found that farm experience positively influenced the adoption of oilseed crops. According to Jensen *et al*., (2007) and Rossi and Hinrichs, (2011), past experience has a beneficial impact on growth propensity and land allocation decisions for oilseed crops.

in canola acreage. The need for canola (and other oilseed) prices considerably above historical norms show that government intervention may be required to ensure adequate oilseed feedstock supply (Wamisho and De Laporte, 2017; Embaye et al., 2018).

People more connected with financial institutes have more chances to get loan for new technology and crops. EU quota schemes may hinder consumers from capturing the benefits of adopting Canola and lower the revenues of technology suppliers (Gardebroek and Hernandez, 2015). Gardebroek and Hernandez, (2018) findings show that insured loans offer great potential for boosting smallholder farmers' access to finance and technology adoption for crop production. Nathaniel and Johnny (2013) investigated the technologies used by northern Ugandan sunflower producers. The findings identified gender, access to financing, market access, investment in agricultural processing equipment, and monetary savings as variables affecting technology adoption for crop production.

7. Conclusion and Recommendations

The study found the factors that influence the decision making about cultivation of oilseed crops specially Canola and Sunflower. Factors such as Education, Farming Experience, Subsidy, Water Issue, Availability of Quality Seed and Quality Pesticide, High Cost of Fertilizer, Low Market Price and availability of Loan have been taken for studying their impact on the decision of farmers for adoption of oilseed crops. The influence of Education and Farming Experience, Subsidy, Water Issue, Availability of Quality Seed and Pesticide, and availability of Loan have positive impact on adoption of oilseed crops. High Cost of Fertilizer and Low Market Price have negative impact on adoption of oilseed crops.

Pakistan is spending heavy amount of foreign exchange on the import of edible oil, theretofore, there is a need to popularize oilseed crops in our country by providing education, quality seeds, pesticides, loans (by making easy access and low interest), quality fertilizer at low cost. In addition to that all the above inputs should be provided at subsidized rates to targeted farmers. Marketing supply chain system is also required to be improved for building the farmers confidence for the disposal of their produce timely and at reasonable price.

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